Energy Efficiency in Chilling Plants

Xin Wang（王鑫）PhD. Candidate

Building Energy Research Centre, Tsinghua University
2006.10.11

清華大學
Tsinghua University

Index

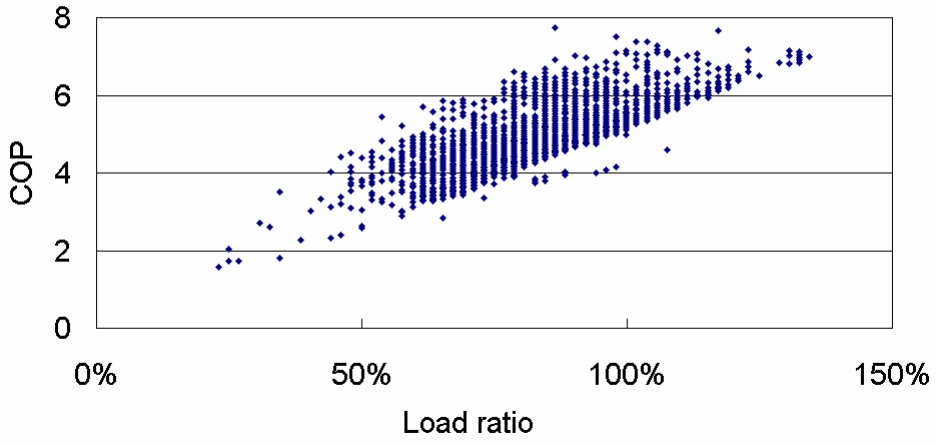
- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

清華大學
Tsinghua University

1.1 Improve load ratio

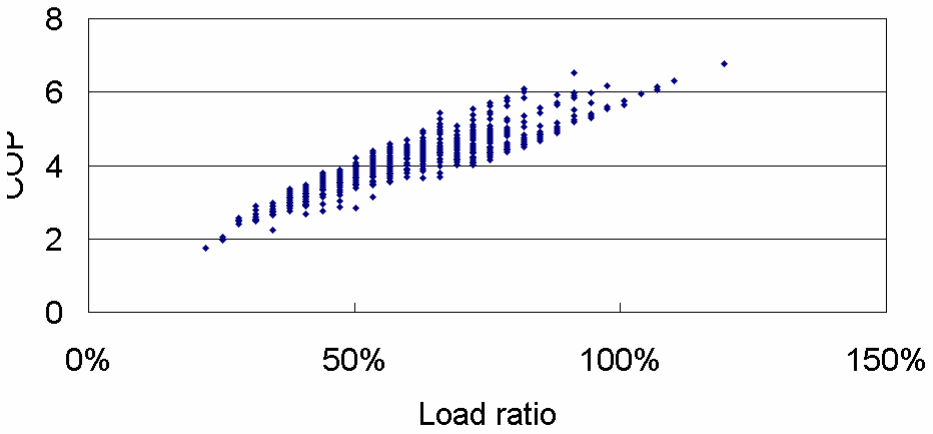
- Characteristic of the centrifugal chillers

The relationship between load ratio and COP of a centrifugal chiller, Shenzhen (2005)



Decrease significantly !

The relationship between load ratio and COP of a centrifugal chiller, Beijing (2004)



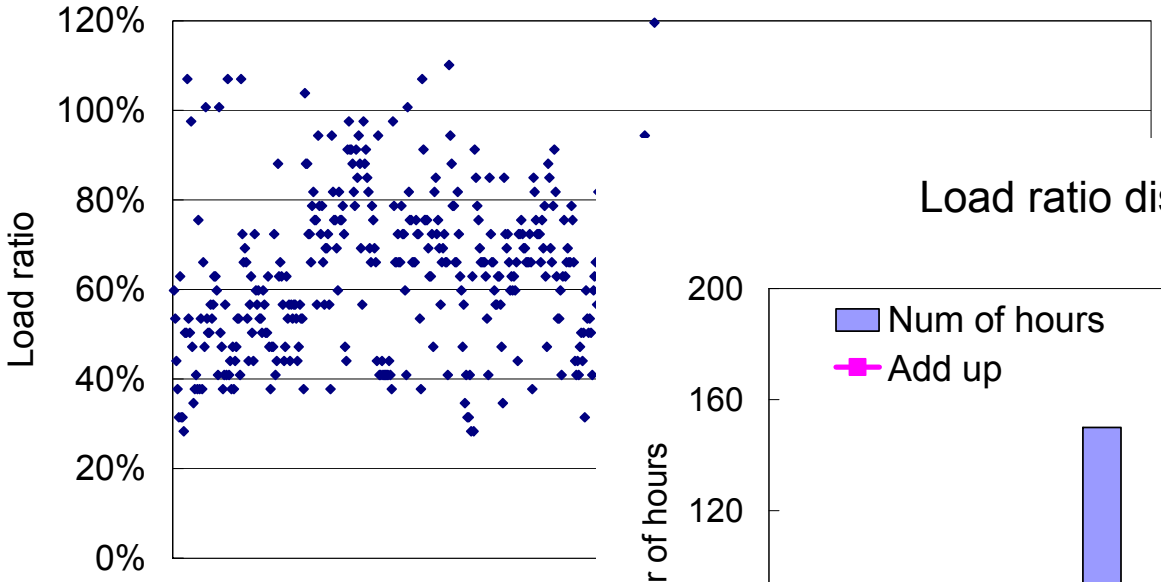
Report of On-site Survey, 2005, 2006

1.1 Improve load ratio

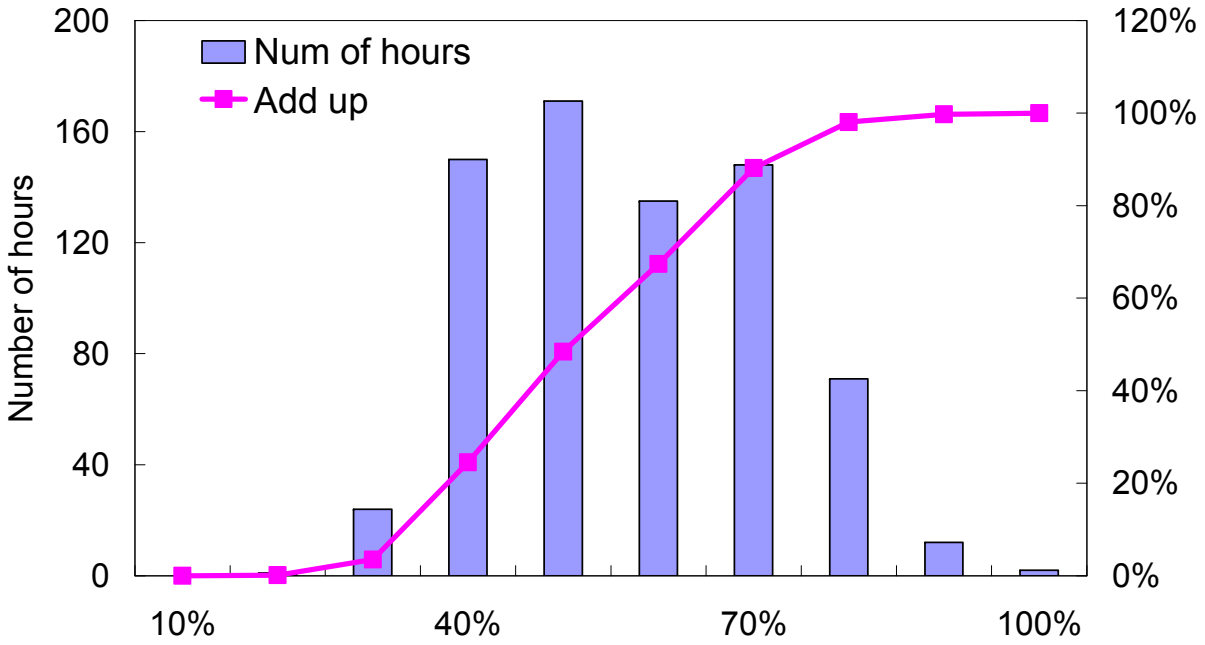
- What caused low load ratio?
  - Oversize chillers
  - Over conservative control strategy

Oversize chillers

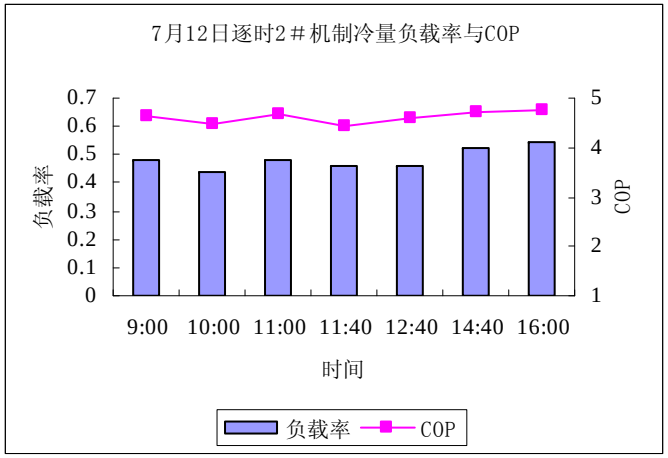
Load ratio distribution of the chillers, Beijing (2004)

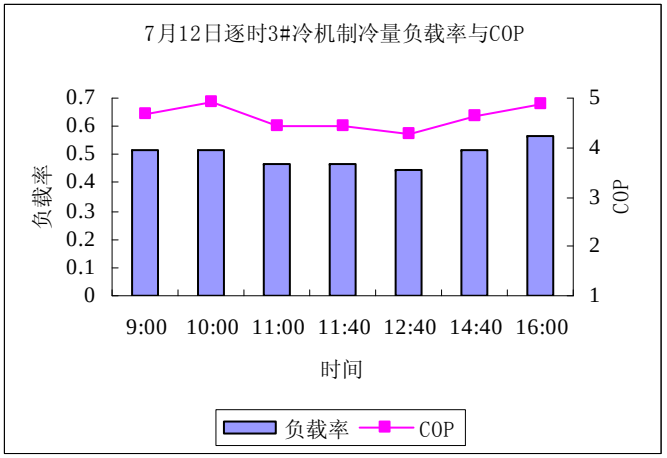


Load ratio distribution of the chillers



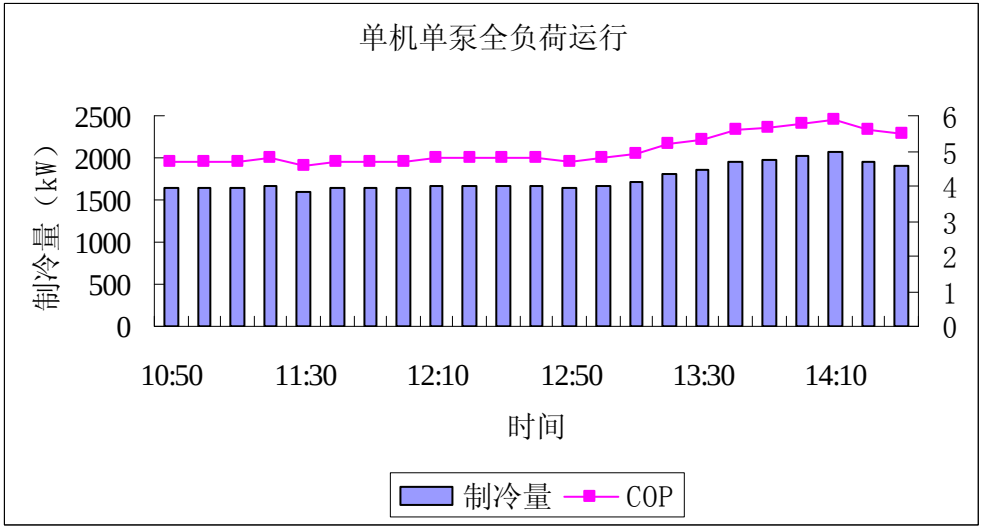
Over conservative control strategy





Saved power of a CHW pump and a CW pump

COP: 4.6→5.0

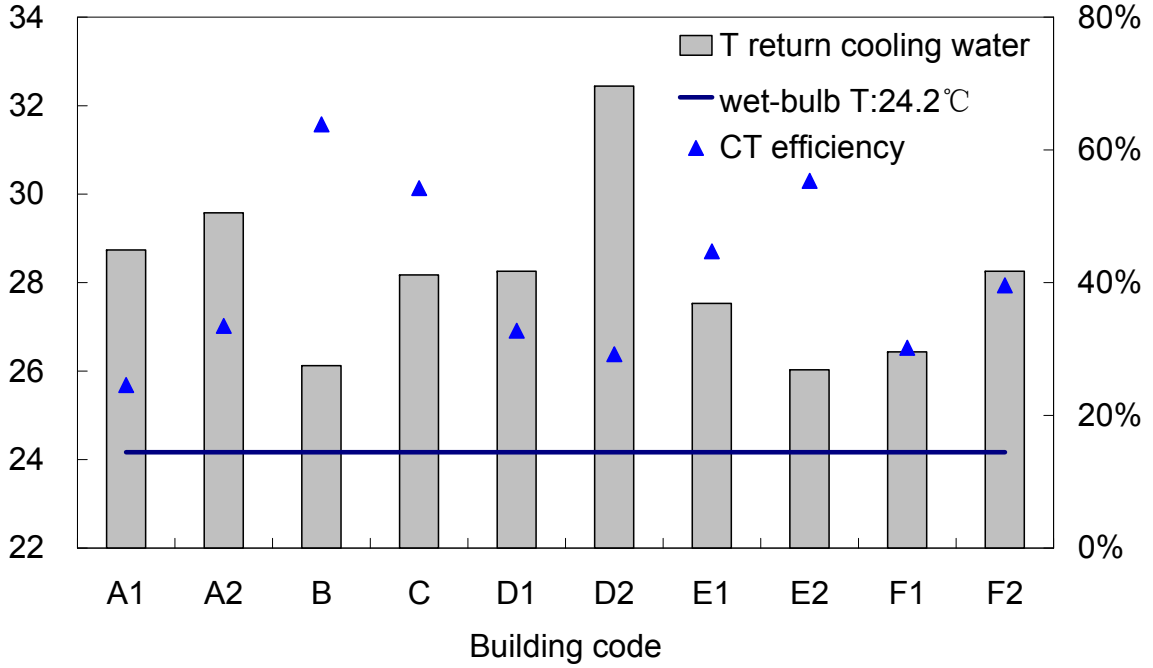


Index

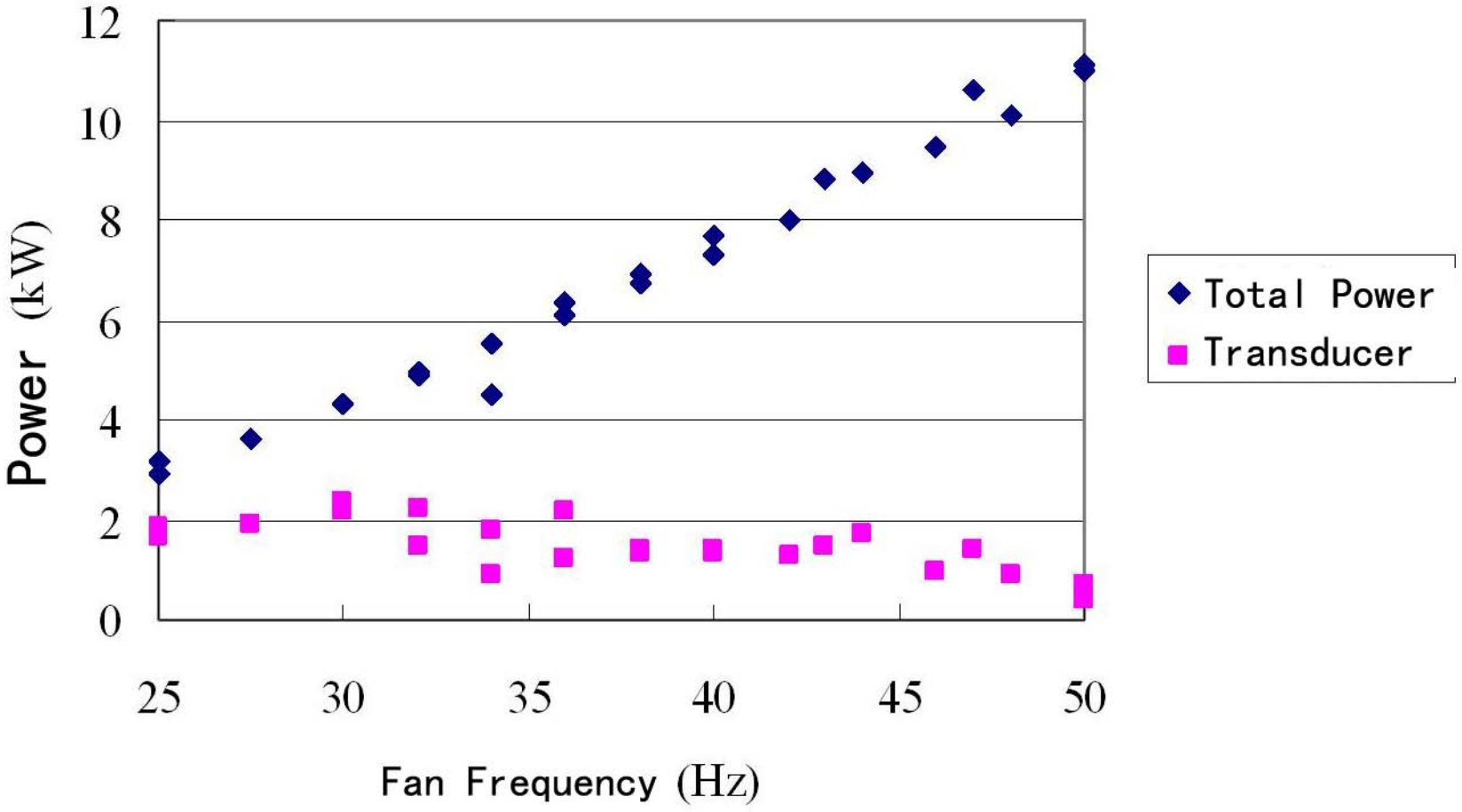
- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

1.2 Decrease CW temperature

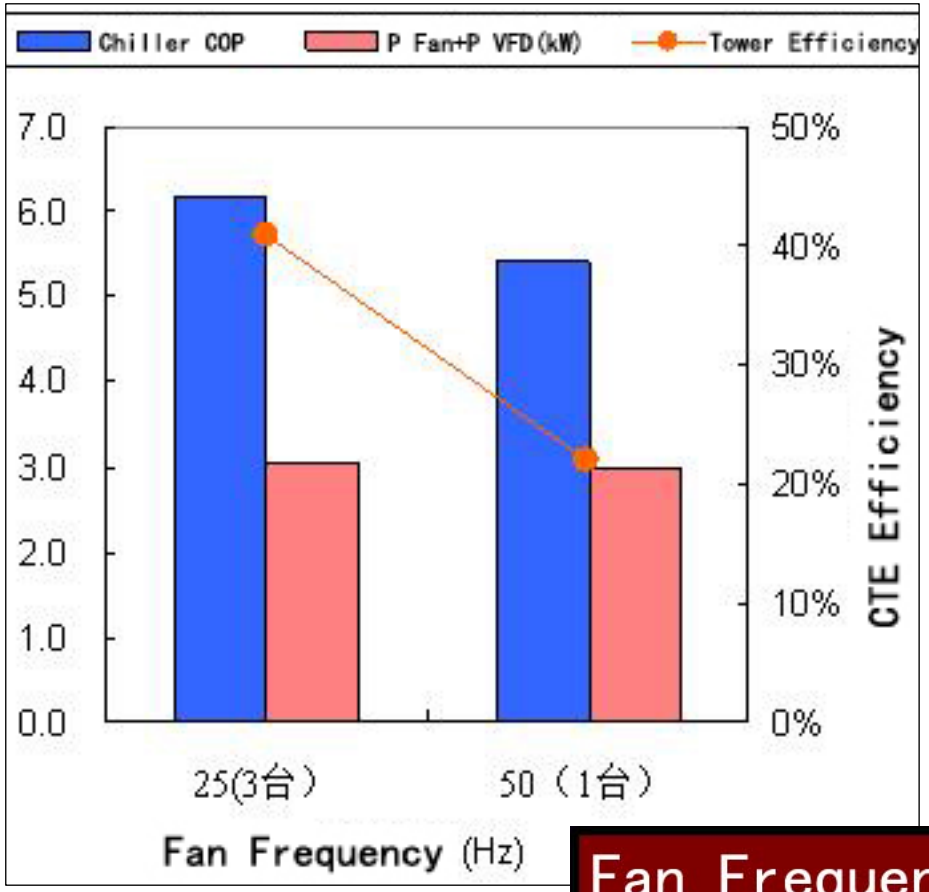
- Different cooling towers' performance
  - in Beijing, 2006-7-11,afternoon



VF of cooling tower fans



Energy Saving Test



Fan Frequency (Hz)	Load (kW)	Power (kW)	Chiller COP
25(3台）	1145	185	6.20
50（1台）	1111	205	5.42

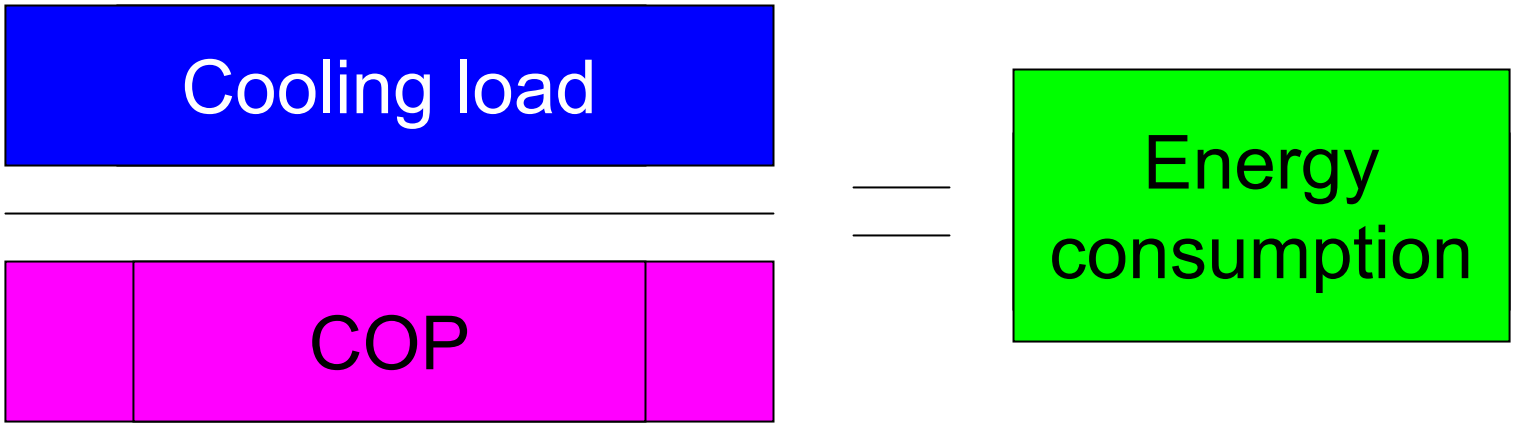
Index

- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

1.3 Increase CHW temperature

CHW Temperature Set (Outlet)	7

Dehumidification?

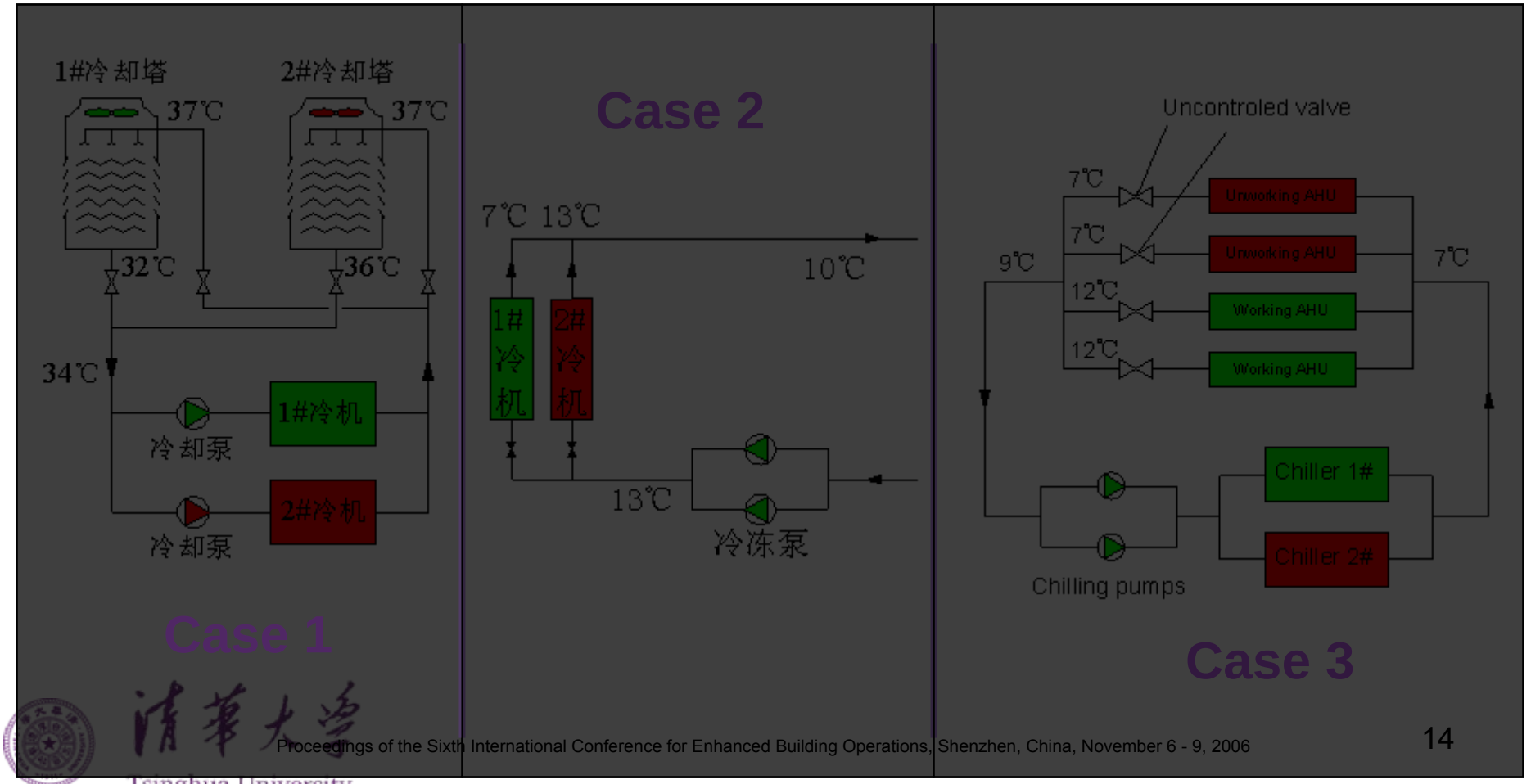


Index

- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

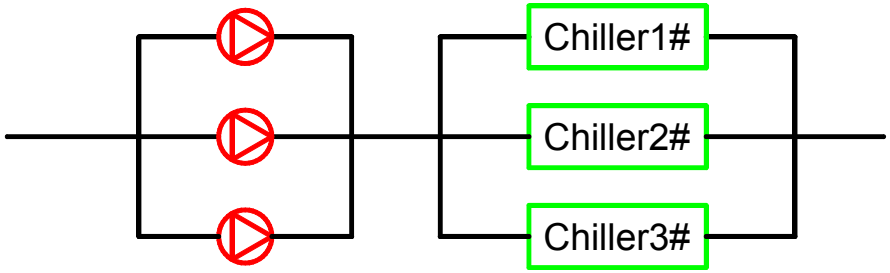
2.1 Avoid unexpected bypass flow

- What is “unexpected bypass flow”?

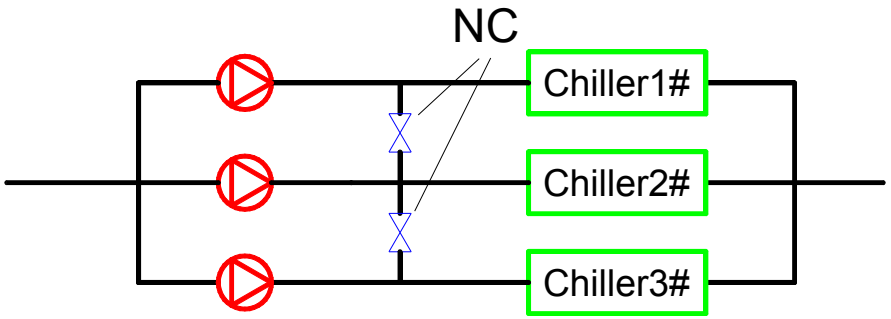


2.1 Avoid unexpected bypass flow

- How to avoid?
  - Shut off the bypass branch manually
  - Add automatic valves on the branches
  - Improved system structure



Common structure of chilling plant
(Easy to bypass)

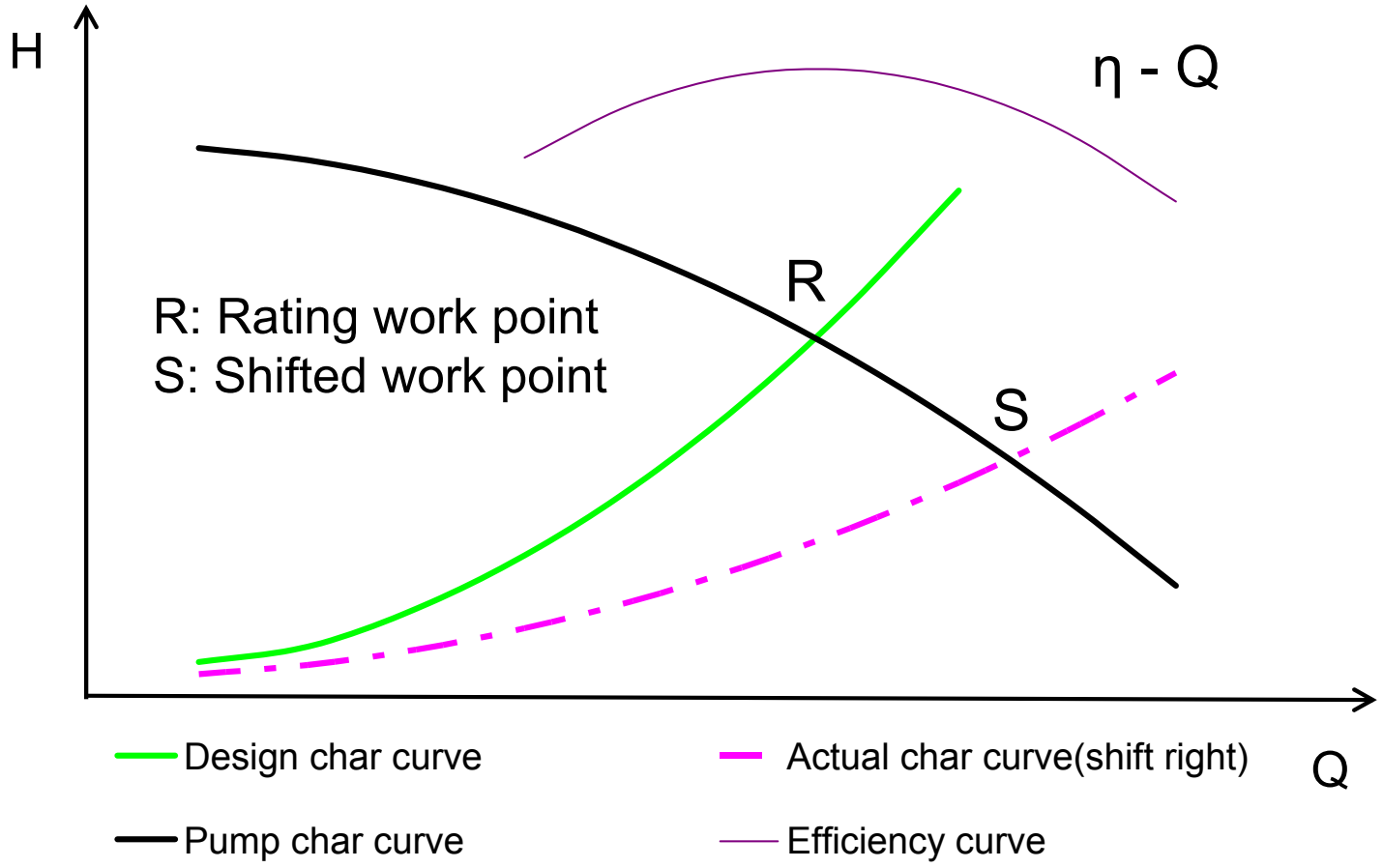


Optimized structure of chilling plant
(Avoid bypass)

Index

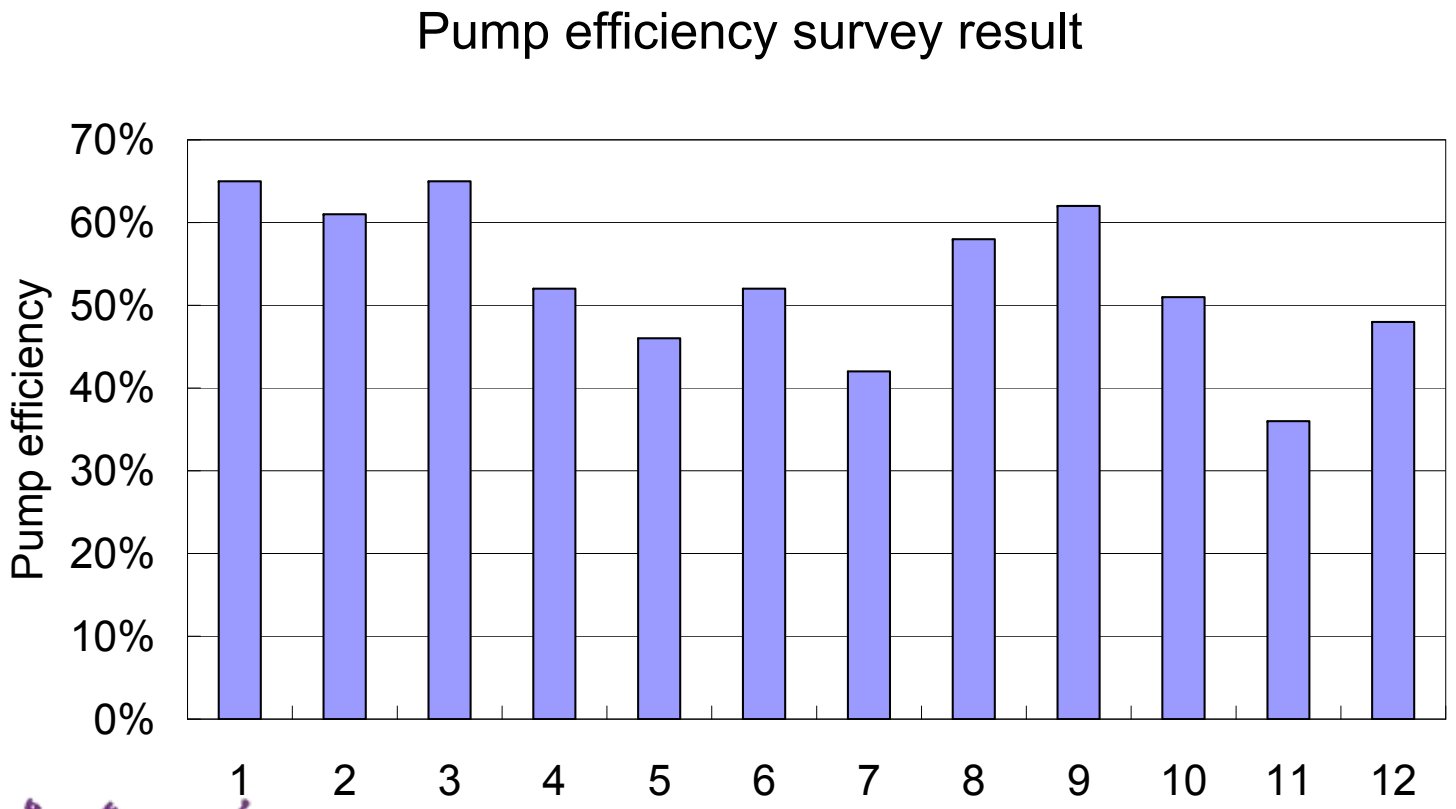
- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

2.2 Keep on the point

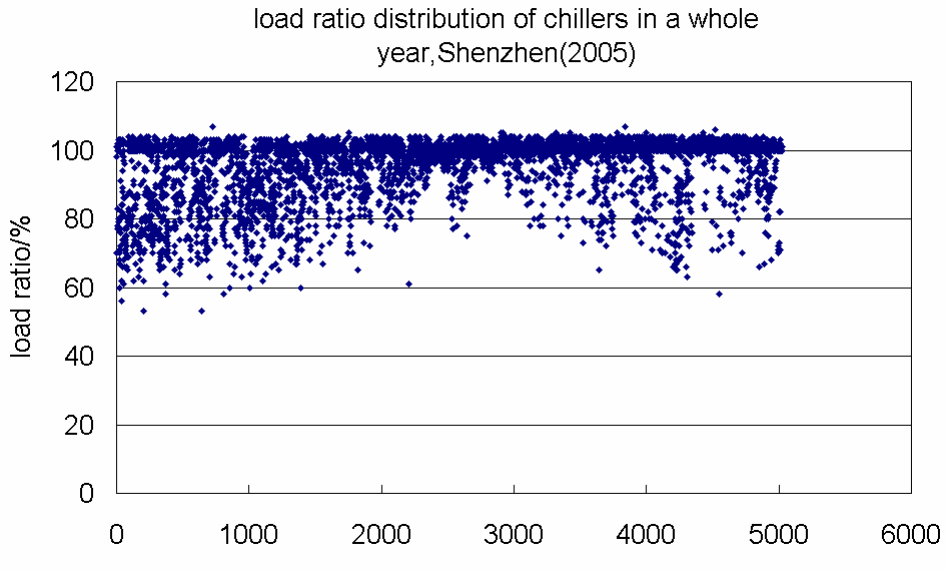


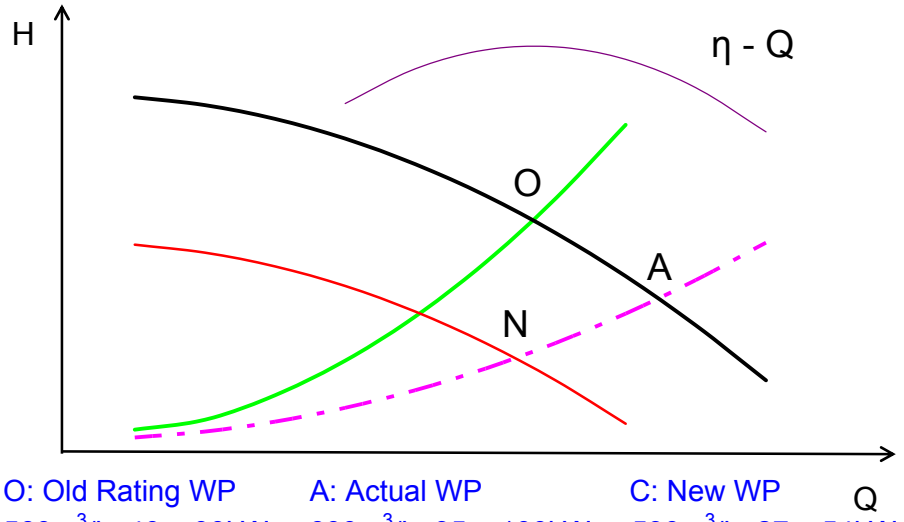
2.2 Keep on the point

- Most pumps' work point is shifted



2.2 Keep on the point





O: Old Rating WP 560m^3/h, 40m,90kW

A: Actual WP 600m^3/h, 35m,100kW

C: New WP 530m^3/h, 27m,54kW

	Pump flow(m3/h)	Pump head(m)	Power(kW)	Efficiency
Design	560	40	90	75%
Actual	600	35	100	57%
After changing the pumps	530	27	54	73%
Inverst	￥120, 000	Anuual benefit		￥165, 000

Index

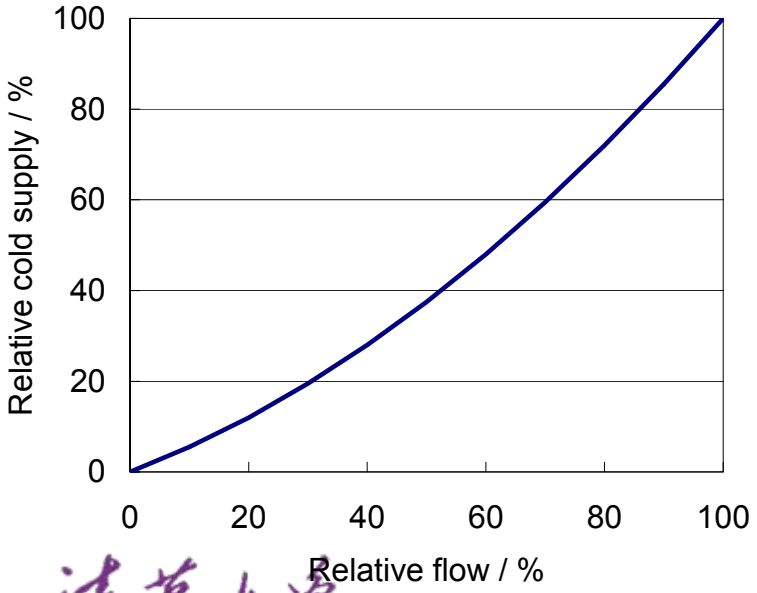
- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

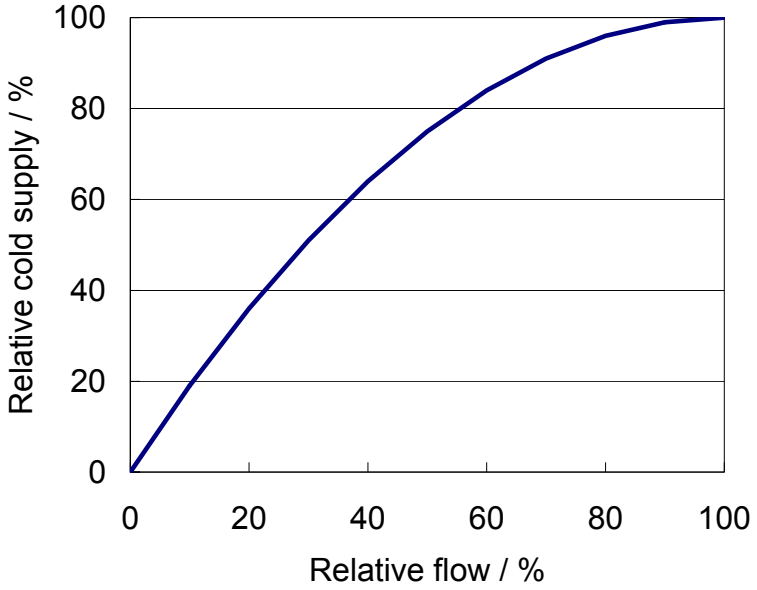
2.3 Optimized VFD control

- Which factors determines the ideal flow?
  - Load demand
  - Terminal characteristics
  - Reliability requirement of chillers

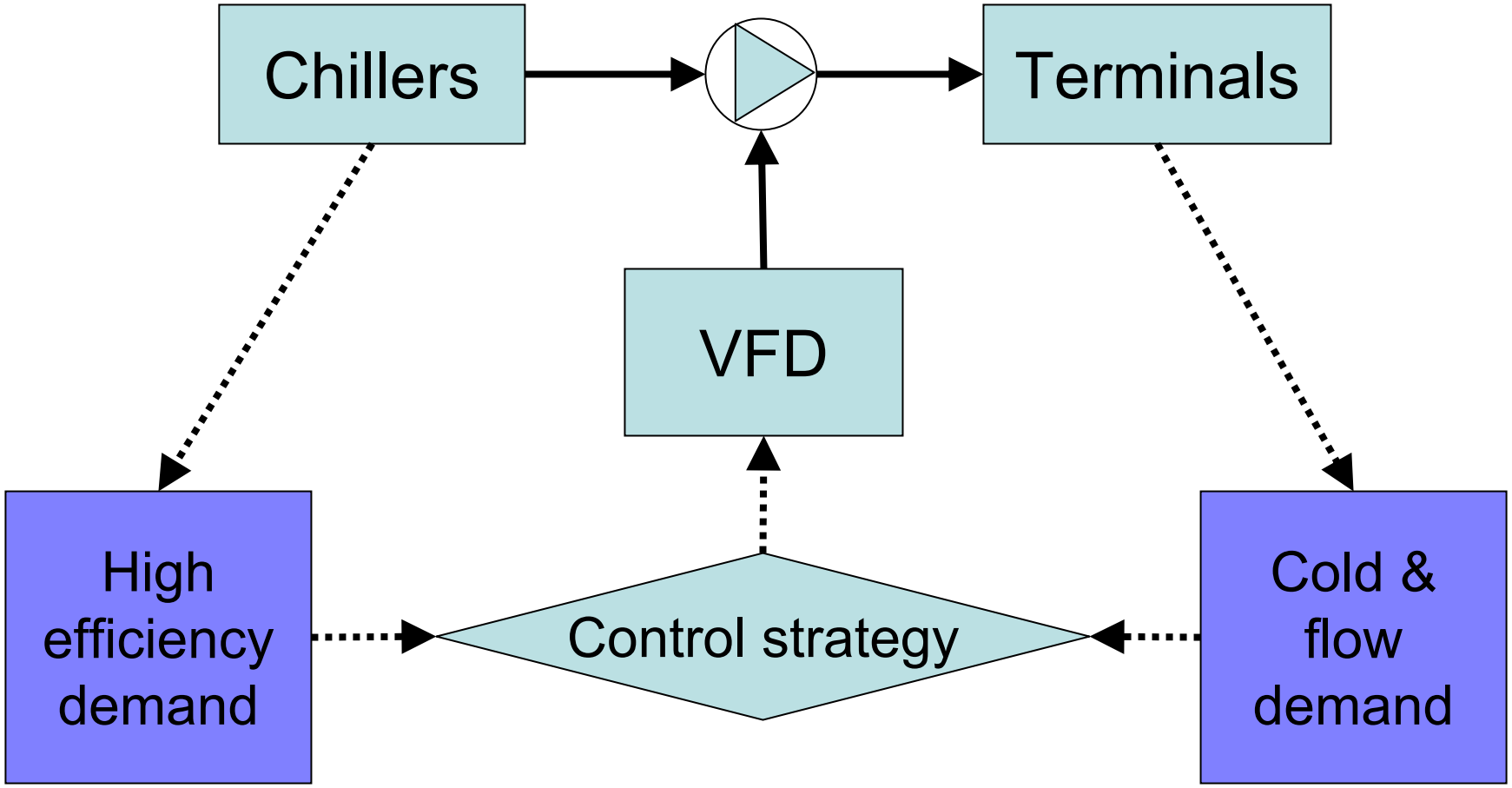
2.3 Optimized VFD control

- Terminal types
  - No control
  - On-Off Control (Fan-coil Unit)
  - Continuous Control (Cooling Coil in AHUs)





2.3 Optimized VFD control



Summary

- Improve COP of chillers
  - Increase load ratio
  - Decrease cooling water temperature
  - Increase chilled water temperature
- Reduce energy use of pumps
  - Avoid unexpected bypass flow
  - Keep Working on higher efficiency point
  - Optimized VFD control

Thank you!